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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/634,274

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Paul A. Farrar

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03/28/2005

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EXAMINER

KEBEDE, BROOK

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 03/28/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/634,274

Applicant(s)

FARRAR, PAUL A.

Examiner

Brook Kebede

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 03 January 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-57 and 104-106 is/are pending in the application.
- 4a) Of the above claim(s) 13-57 and 104-106 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-12 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 5/13/04; 9/10/04; 1/3/05
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse of Group I invention of Species I (i.e., claims 1-12) in the reply filed on September 10, 2004 is acknowledged. The traversal is on the ground(s) that "claim 1 is generic and linked to claims 2-56, as evidence by dependent claims 104-106..." This is not found persuasive.

A restriction requirement between patentably distinct species claims was issued in the Office action that was mailed on August 4, 2004. "Section 121 [of Title 35 USC] permits a restriction for "independent and distinct inventions." Although 37 CFR §1.141 provides that a reasonable number of species may still claimed in one application, it is still proper to restrict claims of different species as long as the Examiner shows *prima facie* case of a serious burden and appropriate explanation of separate classification, or separate status in the art, or a different field of search. For instance, the search of Species I does not necessary covers the search of other species. Such distinct process require an independent search form one another which causes a great burden to the Examiner and it acquired different field of search and that, as a result, a restriction was necessary. An explanation was provided in the restriction requirement. Specifically, in addition to being burdensome, the examiner indicated that restriction is proper because different species in the claims are required "different field of search." Even though claim 1 may be considered generic, due to addition of claims 104 – 106, it is still the restriction is proper. In addition, the added claims also do not fall into Species I. For example, claim 104 belongs species II, claim 105, belongs Species II, and claim 106 belongs in Species IV.

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The criteria of distinctness and burdensomeness have been met, as demonstrated hereinabove. Accordingly, the restriction requirement in this application is still deemed proper and is therefore **made FINAL**.

2. Claims 13-57 and 104-104 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected species, the requirement having been traversed in the reply filed on September 10, 2004.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 1-12 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1 recites the limitation “depositing a **capping adhesion/barrier layer** on the core conductive layer” in line 6.

However, the limitation “**capping adhesion/barrier**” layer is not clear and confusing. Does it mean that the capping layer is also adhesion layer? Does it mean that the capping layer also barrier layer? Does it mean that the capping layer can be either adhesion layer or barrier layer? Does it mean that the capping layer act as both an adhesion and barrier layer? and etc. The recited claim lacks clarity in its meaning and scope. Therefore, the claim is being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 2 recites the limitation “ wherein forming a first conductive layer includes

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depositing a seed layer on a **first adhesion/barrier layer**” in line 1-2. There is lack of antecedent basis for **“first adhesion/barrier layer.”**

In addition claim 2 lacks clarity for **“first adhesion/barrier layer”** as applied for claim 1 above.

Claim 3 recites the limitation “wherein depositing a seed layer on a **first adhesion/barrier layer**” in line 1-2. There is lack of antecedent basis for **“first adhesion/barrier layer.”** In addition claim 3 lacks clarity for **“first adhesion/barrier layer”** as applied for claim 1 above.

Claims 4, 5 and 8-12 lacks clarity for **“capping adhesion/barrier”** as applied for claim 1 above.

Claims 2-12 also rejected as being directly or indirectly dependent of the rejected independent base claim.

In light of the rejection 35 U.S.C. § 112 second Paragraph that set forth herein above, the following 35 U.S.C. 103 rejection is based on prior art which reads on the interpretation the claim language of the instant application as best as understood by the Examiner.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farr (US/6,376,370) in view of Agnello et al. (US/6,255,217).

Re claim 1, Farrar discloses a method for forming an electronic device comprising: forming a first conductive layer (320) (see Fig. 3F) in an opening (310) in a dielectric structure (308) supported by a substrate (300); forming a core conductive layer (344) (see Fig. 3K) on the first conductive layer (320); and depositing a capping layer (346) (i.e., TiN layer) on the core conductive layer (344) (see Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7).

However, Farrar does not disclose subjecting the conductive core layer to a H₂ plasma treatment prior formation of the capping layer.

Agnello et al. disclose method for forming an electronic device comprising depositing of the core conductive layer (20) (i.e., copper layer) into the opening (see Fig. 1) and treating the surface of the core conductive layer with hydrogen plasma (see Col. 2, line 21-56) prior to depositing of an inorganic barrier (capping) layer (24) in order to increase surface adhesion of the of the inorganic barrier to the copper conductive layer (see Col. 2, lines 33-56).

Both Farrar and Agnello et al. teachings are directed to method of fabricating copper damascene interconnect devices. Therefore, the teachings of Farrar and Agnello et al. are analogous.

Hence, one of ordinary skill in the art would have been motivated to look to analogous art teaching hydrogen plasma treatment of copper wire layer prior formation of the barrier layer as disclosed by Agnello et al. in order in order to increase surface adhesion between the copper wire and the barrier layer while reducing the native oxide that formed on the copper layer.

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Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Farrar reference with teaching hydrogen plasma treatment of copper wire layer prior formation of the barrier layer as taught by Agnello et al. in order to increase surface adhesion between the copper wire and the barrier layer.

Re claim 2, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming a first conductive layer includes depositing a seed layer on a first adhesion/barrier layer (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 3, as applied to claim 2 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing a seed layer on a first adhesion/barrier layer includes depositing the seed layer on a layer of a refractory metal, a compound of nitrogen and a tantalum alloy, or a compound of nitrogen and a tungsten alloy (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 4, as applied to claim 2 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing the seed layer and the capping adhesion/barrier layer includes depositing the seed layer and the capping adhesion/barrier layer using low energy ion implantation (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 5, as applied to claim 4 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing the seed layer and the capping adhesion/barrier layer using low energy ion implantation includes using an

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implant energy ranging from about 0.1 keV to about 0.8 keV (i.e., within the overlap claimed region of 0.1 keV to 2 keV) (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 6, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming a core conductive layer includes depositing the core conductive layer using a CVD process (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 7, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming a core conductive layer includes forming the core conductive layer at predetermined temperature. Furthermore, the claimed temperature range can be optimized by routine experimentation in order to achieve the desired thickness and surface roughness of the conductive layer (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

One of ordinary skill in the art would have been motivated to optimize the deposition temperature of the conductive layer by using routine experimentation in order to achieve the achieve the claimed temperature range.

Therefore, it would have been to one having ordinary skill in the art at the time of the invention is made to deposit the copper conductive layer at temperature range of room temperature to 250 C, since it has been held where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” See *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955); *In re Hoeschele*, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969); *Merck & Co. Inc. v. Biocraft*

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Laboratories Inc., 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), cert. denied, 493 U.S. 975 (1989); *In re Kulling*, 897 F.2d 1147, 14 USPQ2d 1056 (Fed. Cir. 1990); and *In re Geisler*, 116 F.3d 1465, 43 USPQ2d 1362 (Fed. Cir. 1997). Furthermore, the specification contains no disclosure of either the critical nature of the claimed temperature range or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. See *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d, 1936 (Fed. Cir. 1990).

Re claim 8, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing a capping adhesion/barrier layer includes depositing one or more materials selected from titanium, zirconium, hafnium, and nitrides of these elements (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 9, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing a capping adhesion/barrier layer includes depositing the capping adhesion/barrier layer having a thickness range of 5 Å to 150 Å (i.e., within the claimed range of ranging from about 5 Å to about 40 Å) (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 10, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein the method further includes removing at least a portion of the dielectric structure, after depositing the capping adhesion/barrier layer on the core conductive layer, to form an air bridge structure (see Farrar

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Col.5, lines 7-8) (see also Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 11, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming a core conductive layer and depositing a capping adhesion/barrier layer includes forming the core conductive layer and depositing the capping adhesion/barrier layer in the opening in the dielectric structure, the dielectric structure having multiple dielectrics layers, such that the core conductive layer and the capping adhesion/barrier layer are within one dielectric layer in the dielectric structure with a top surface of the capping adhesion/barrier layer substantially level with a top surface of the one dielectric layer (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 12, as applied to claim 11 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming the core conductive layer and depositing the capping adhesion/barrier layer within one dielectric layer includes forming the core conductive layer and depositing the capping adhesion/barrier layer within a polymer layer, a foamed polymer layer, a fluorinated polymer layer, a fluorinated oxide layer, or an aerogel layer (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure Avanzino et al. (US/6,350,687), Ngo et al. (US/6,562,416) and Chen et al. (US/2004/0161924) also disclose similar inventive subject matter.

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Correspondence

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brook Kebede whose telephone number is (571) 272-1862. The examiner can normally be reached on 8-5 Monday to Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (571) 272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Brook Kebede
Examiner
Art Unit 2823

Brook Kebede

BK
March 14, 2005